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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 3 :
B65D 88/16, 88/62, 90/04

A1

(11) International Publication Number: WO 82/ 03839

(43) International Publication Date:
11 November 1982 (11.11.82)

(21) International Application Number: PCT/US82/00510

(22) International Filing Date: 22 April 1982 (22.04.82)

(31) Priority Application Numbers:
257,604
307,089
357,589
357,592

(32) Priority Dates:
27 April 1981 (27.04.81)
30 September 1981 (30.09.81)
12 March 1982 (12.03.82)
12 March 1982 (12.03.82)

(33) Priority Country: US

(60) Parent Applications or Grants
(63) Related by Continuation
US 357,592 (CIP)
Filed on 12 March 1982 (12.03.82)
US 357,589 (CIP)
Filed on 12 March 1982 (12.03.82)
US 307,089 (CIP)
Filed on 30 September 1981 (30.09.81)
US 257,604 (CIP)
Filed on 27 April 1981 (27.04.81)

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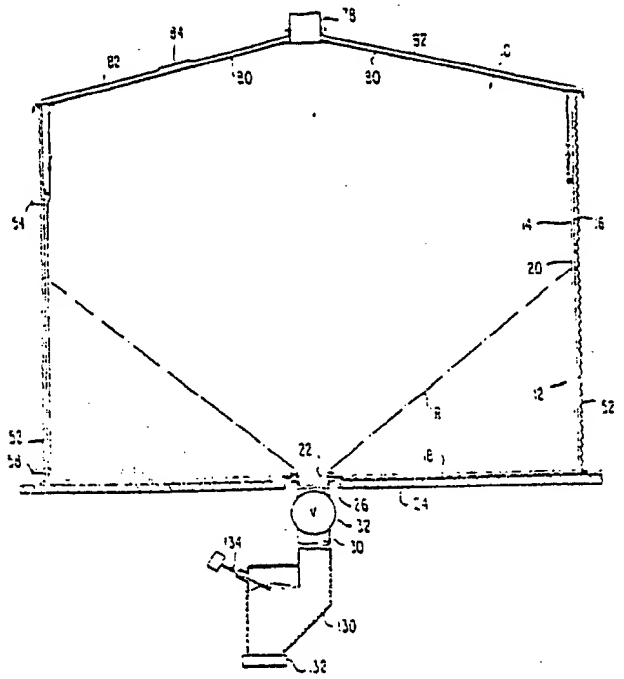
(81) Designated States: AT (European patent), AU, BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US.

Published
With international search report.
With amended claims.

(54) Title: BIN FOR STORING AND DISCHARGING FREE FLOWING GRANULAR MATERIAL

(57) Abstract

A flat-bottomed bin (10) for the bulk storage and discharge of flowable granular materials. Because all of the material in such a bin cannot be discharged by gravity alone, a flexible, dual-wall, cup-shaped bag (12) is supported from and within a bin wall. The cup shaped bag rests on the flat bottom (24) of the bin and contains the granular material to be discharged. The granular material is discharged through a discharge opening (22) of the bag by operation of gravity until the remaining granular material reaches its angle of repose. Then the bin is further emptied by gravity due to inflating the bag to expand its inner wall (14) inwardly. The bag may have either a central discharge opening or a side discharge opening.



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BIN FOR STORING AND DISCHARGING FREE FLOWING GRANULAR MATERIAL

Field of the Invention

The invention relates to bulk storage bins with fluid pressure assisted gravity discharge for material in the bin after it assumes its angle of repose.

Prior Art

Free flowing granular material, e.g. sugar, sand, rice, etc. is often stored or contained in silos or bins having rigid walls and bottoms made of metal or some other rigid material. A discharge port is generally provided in the bottom of such a bin or silo, which, when opened, permits the material in the container to flow out. From the discharge port, the material may be conveyed away by a conveying means such as a screw conveyor. If the bottom of the silo or bin, extending from the discharge port to the walls, is flat or horizontal, not all of the free flowing granular material will be discharged through the discharge port by gravity. It is a characteristic of free flowing granular material contained in a flat bottomed bin or silo to stop flowing out the discharge port when the material remaining in the bin is at an angle of repose. The material remaining in the bin after discharge by gravity, forms an invented partial cone shape inside the silo. The face of the of free flowing granular material, extends for the discharge port in the bottom or wall of the silo upward at an angle to the wall of the silo or bin.

To ensure the discharge of the entire contents of a bin, bins have been provided with hopper bottoms. These hopper bottoms have inclined sides, extending upward from the discharge port at an angle towards the bin walls. The angle at which the hopper bottom projects from the discharge port to the bin wall is sufficient to prevent the material in the bin from resting at an angle of repose and to direct the entire contents of the bin towards the

discharge port for removal. The shape of the bottom concentrates the weight of the hopper on a smaller area than a flat bottomed silo or bin of the same size. In addition, a bin with a hopper bottom has a higher center of gravity than the same sized bin with a flat bottom. A hopper shaped bin is expensive and wasteful of space.

The general concept of using pneumatically movable flexible membranes inside a container to move materials in the container is known. See, e.g. W. German Offenlegunschrift 2705689 (1968). However none of such prior art has, to applicants knowledge, suggested using a dual-wall, flexible, cup shaped inflatable bag as the storage bin with its inner wall moveable by pneumatic pressure to cause stored materials to flow by gravity from their angle of repose toward a discharge opening in the bag.

Summary of the Invention

The invention may be described in summary as: a bin for free flowing granular material having a bottom resting on a support member and a bin structural side wall extending upward from said bottom and a penumatically actuable flexible membrane for forcing the free flowing granular material toward a discharge opening in the bin, with the improvements comprising; a hollow, inflatable, flexible, generally cup shaped bag having an inner wall and an outer wall with a discharging opening therethrough, means for suspending the top of the bag from the side wall and attaching the outer wall of the bag to the bottom of the side wall, means for inflating the hollow flexible bag after the bin has been partially emptied by gravity to force remaining material to flow by gravity out the discharge opening, and means for deflating the hollow bag and causing it to assume its original position.

Detailed Description of the Drawings

Fig. 1 is a sectional elevation view partially schematic of one embodiment of the storage and discharge bin of this invention having a center discharge.

Fig. 2 is a fragmentary sectional elevation view of a portion of the bin around the discharge opening shown in Fig. 1.

Fig. 3 is a partial sectional elevation view of a portion around the bottom outside edge of the bin shown in Fig. 1.

Fig. 4 is a detailed sectional elevation view of a portion of the upper side edge of the bin shown in Fig. 1.

Fig. 5 is a partial sectional elevation view, also partially schematic, illustrating another embodiment of this invention.

Fig. 6 is a partial detailed elevation view of a portion of the embodiment shown in Fig. 5.

Fig. 7 is a schematic side elevation view of another embodiment of this invention and its controls;

Fig. 8 is a detail elevation view of a top cover of the bin;

Fig. 9 is a detail sectional view of the means for attachment of the bag to the bin walls;

Fig. 10 is an elevation view looking along line 10-10 of Fig. 7;

Fig. 11 is a detail sectional elevation of the discharge area of the bin;

Fig. 12 is a partial sectional elevation of another embodiment of the invention;

Fig. 13 is a view taken along line 13-13 of Fig. 12;

Fig. 14 is a partial sectional elevation of another embodiment of the invention;

Figs. 15A-15F are a series of schematic views showing the sequence of conditions and actions in unloading the bin.

Fig. 16 is a schematic side elevation of another embodiment of the side unloading bin of this invention.

Figs. 17A-17D are a series of schematic views showing the sequence of conditions and actions in unloading the bin of Fig. 16.

Figs. 18A-18F are a series of schematic views showing the sequence of conditions and actions in deflating the flexible cup shaped bag.

Fig. 19 is a schematic view of a safety pressure relief system for the bag.

Detailed Description of the Preferred Embodiments

As shown in Fig. 1 a storage bin 10 for storing and discharging free-flowing granular material is provided with an inflatable, double-walled, flexible cup-shaped bag 12 having an inner wall 14 and outer wall 16. The bag 12 provides a bottom 18 and side walls 20 of a flexible bin for storing free-flowing granular materials which may be discharged through a discharge opening 22.

The bin rests on a floor 24 having an opening 26 to accommodate discharge of the materials from the bin. A discharge conduit 30 with any suitable type gate or valve valve means 32 may be utilized to control the discharge of material from the bin.

To discharge the free flowing granular material from a bin constructed in accordance with this invention the gate 32 of the discharge opening 26 must be opened. The contents of the bin may then flow out the opening to be carried away by a conveying means, such as a screw conveyor (not shown), or to be discharged into a moveable container for transport to a different area. The free flowing granular material will continue to flow out of the bin through the discharge port by gravity until the angle of repose for the particular material in the bin is reached, or nearly reached. At the angle of repose, the inner face R of the free flowing material assumes an

inverted cone shape with its apex at the discharge opening and discharge of the material by gravity stops.

To overcome the angle of repose and complete the discharge operation, air under low pressure is forced into the bag 12 between the inner and the outer walls. The bag 12 begins to inflate at the top of the bin and bulge inwardly towards the center of the bin. This inflation forces the free flowing granular material nearest the top of the inverted cone to cascade down towards the discharge opening by gravity. The pneumatic pressure within the cup shaped bag needs to be relatively low, e.g. about 1/4 to 1 psi, sufficient to overcome the limited resistance caused by the small quantity of granular free flowing material at the top of the inverted cone.

As air continues to inflate the bag, the inner wall 14 extends further towards the center of the storage area until full inflation is achieved and substantially the entire contents of the bin are discharged through the discharge opening.

The flexible cup-shaped bag 12 is anchored adjacent the discharge opening to a stationary member such as the floor opening 26 or conduit 30. In the embodiment illustrated in Fig. 2 it is anchored to the conduit 30 by means of a flat annulus 34 and a flange 36 forced together by a nut and bolt 38 to sandwich the ends of the inner and outer bag walls 14 and 16 adjacent the discharge opening 22. To assist in the anchoring a rope 40 may be secured to the end of the inner wall 14 by an extra loop of material and a heat seal 42 provided, as illustrated in Fig. 2.

The outer edge of the bottom portion and lower side wall of the cup-shaped bag 12, and particularly the outer wall 16, are anchored to the floor 24 as shown in detail in Fig. 3. Also, the inner wall 14 may be of such size as to require an additional portion of the inner wall to be cemented or heat-sealed to the bottom portion as shown at heat seal 44. The outer wall 16 is looped around a rope 46 and doubled back and heat-sealed at 48. A stud 50

extending from floor 24 has a nut 51 screwed down against a flange 54 of a corrugated side wall 52 sandwiching the bottom edge of outer wall member 16 between the flange 54 and the floor 24.

The anchoring arrangement shown in Figs. 2 and 3 assists in preventing the flexible wall bag from tilting due to large forces of the stored material if it shifts due to loading or unloading. Additionally, wall 52, which may conveniently be corrugated material such as used for grain bins, farm buildings or the like, provides some lateral load support for the outer flexible wall 16. The wall 52 extends upwardly as shown in Fig. 1 and surrounds the outside of the flexible cup-shaped bag 12.

There is provided an opening 54 into the space between the walls 14 and 16 near the top of the side walls of the bag for inflating the bag 12. There is also an exhaust opening 58 near the bottom of the side walls between the walls of the bag as shown in Fig. 1.

As shown in Fig. 4, the corrugated side wall 52 has a top flange 60. A suitable means for providing slack at the upper portion of the side walls to assist in the discharge includes a slack loop 62 in the upper end of wall 14 which is held up by means of a heat-sealed or cemented loop 64 of fabric material, an O-ring 66 and a coil spring 68 hooked to the O-ring and to a support 70. A hoop 72 is secured to the side wall 52 by a nut and bolt 74 to provide support from the side wall for the outer flexible wall 16. A rope 76 and heat seal arrangement similar to that previously described is also provided as shown in Fig. 4. An extension of the outer flexible wall 16x may extend upwardly over flange 60 and be sandwiched between flange 60 and spring support 70 and secured by nut and bolt 77.

As shown in Fig. 1, material may be placed into the storage bin via an inlet chute 78 which may be supported from building structure, not shown, and connected to tension cables 80 extending to the spring support 70. A fabric roof 82 of a material similar to that from which the

flexible walls of the flexible wall bag are made is provided to cover the top of the bin. The roof has a one-way vent 84 which will allow air to escape from the bin when the bin is being filled, but will not allow dust or particulate material from the granular free-flowing material to escape.

The slack provided by slack loop 62 assists in the inflation of the bag to discharge the flexible free-flowing material from its angle of repose R in Fig. 1. After material is discharged down to the angle of repose R, fluid under pressure such as air is blown into inlet 56 which initially inflates the flexible loop 64 providing a good start for the flexible wall assisted discharge of the material.

Another and alternative embodiment for providing slack in the inner side wall at the top of the material after discharge to the angle of repose and to assist in the discharge is shown in Figs. 5 and 6, where in the same reference numbers indicate the same parts as previously described. Figs. 5 and 6 show, however, a separate inflatable annulus or tire 86 with a separate inflation opening 88. The tire may be inflated to create a bulge or slack in the inner side wall 14 as shown in Fig. 5. The side wall 14 is secured to the corrugated wall 52 by means of hoop 72 and nut and bolt 74 as shown in Fig. 6.

A center discharge side-unloading bin which does not require a hole in the bottom of the supporting floor can be accomplished by providing a false, or raised, floor to create a discharge well at least in the discharge area of the center of the bin and an elongated, closed casing conveyor extending from this raised discharge well to the side of the bin.

The slack above the angle of repose near the top of the flexible side walls of the cup-shaped bag eliminates undue stress at that point during the initial inflation period. The corrugated wall back-up support allows the use of a lighter-weight fabric material and prevents puncturing

of the flexible bags. The anchoring to the floor at the outer corners of the outer wall prevents tipping or tilting and is conveniently accomplished by securing this wall under a flange of the corrugated wall.

Embodiments of the invention in side unloading form are shown in Figs. 7-18. Referring to Fig. 7, a bin 10' of this invention is especially suitable and adapted for bulk storage and handling (discharging) free flowing granular material. The bin is supported on a floor or other support 12' having suitable strength to bear the load of the material in the bin. The bin is constructed with side walls 14' which are preferably light weight corrugated metal of the type commonly used for farm grain bins, buildings and the like. The side walls 14' have formed therethrough a discharge opening 16' in the lower portion thereof.

The bin is optionally provided with a suitable top 18' which may be either metal or cloth and preferably has vent means therein (not shown) to allow venting of air from the bin when it is being filled while preventing loss of dirt size particulate material. A suitable loading chute 20' may be supported from the upper floor 22', for example. However, any suitable known means can be used for putting material to be stored into the bin.

The bin side walls 14' have flanges at both ends including flange 24' around the upper periphery of the side wall and flange 26' at the bottom edge of the side wall. Within the bin there is an inflatable generally cup-shaped bag 28' having an inner wall 30' and an outer wall 32'. A portion of the outer wall 32' may be held beneath the lower flange 26' of the side wall 14' and an upper extension of inner bag wall 30' may be supported over the top of bin side wall flange 24'. The bottom flange 26' is bolted or othwerwise securely attached to the floor by conventional securing means, see Fig. 3.

There is provided through the outer wall 32' of the bag and wall 14' of the bin an inflation opening 34' and a

deflation opening 36'. Although the inflation opening is shown near the top of the cup shaped bag, it can be at any other suitable location.

The top of the double walled bag 28' is slanted and the top of the two bag walls are clamped together by a clamp 38'. This clamp spirals around the bin from a high portion near the top of the bin opposite the discharge opening 16' to a lower portion above the discharge opening, see Fig. 7.

The clamp 38' is shown in detail in Fig. 9 and includes a pair of metal straps 40' sandwiching the ends of the inner and outer wall 30' and 32' and the end of inner wall extension 42' therebetween. The assembly is clamped together and clamped to the bin side wall 14' in numerous locations by a nut and bolt means 44'. The ends of the flexible material bags may have rope 46' around them for securing in the clamp.

The inner and outer bag walls 30' and 32' may in some instances be glued together so that they may not inflate in a generally triangularly shaped area 48' extending above and outwardly from the discharge opening 16', see Fig. 10. This prevents the walls from separating upon inflation of the bag. However, such adherence was not necessary in handling sugar, and its use is optional. Both walls of the bag 28' are sealed around the discharge opening by a plate 50' abutting against a backup plate 51'.

A discharge shroud 52' shown in detail in Fig. 11 extends outwardly from the bin discharge opening a distance sufficient so that the material in the bin can flow into a discharge conveyor by gravity. The discharge shroud 52' includes side walls 54', a top wall 56' and a bottom wall 58'. A transparent hatch 60' having a handle 62' is hinged at 64' for closing the top of the discharge shroud and providing access to material therein. At the bottom of the shroud 52' there is a screen 66' for screening the material and a gate valve 68 which may be operated by handle 70'. Below the discharge shroud and particularly below the gate

valve 68' there is a screw type conveyor 72' in a conveyor housing 74' for conveying away material discharged. Because the discharge opening 16' is above the level of the floor 12' a built up floor segment 75' is provided.

For inflation and deflation of the bag there is provided a blower 76', see Fig. 7, having an outlet line 78' with valves 80' and 82' controlling whether the output of the blower is directed to inflating the inflatable bag 28' through line 86' or venting to atmosphere. Alternatively the blower could just be turned on when air pressure is required. Line 86' is provided with a check valve 88' to prevent collapsing of the bag during an emptying cycle or if the blower stops. There is a further line 87' connected to deflation opening 36' leading back to the inlet of the blower 76' and controlled by valves 90' and 92'. A control box 84' is provided with suitable controls for controlling valves 80', 82', 90' and 92'. The control box can also be used to directly control the switching on and off of the blower thus eliminating some of the automatically controlled valving. Manually controlled valves would then be used to select either inflation or deflation.

In connection with the controls, there is a material indicator 94' of a commercially available type (e.g. Z-tron level switch made by Dexelbrook Engineering) which indicates when there is material flowing over it in the bin. This material indicator is positioned just adjacent the discharge in an area just outside the normal boundary of the material emptied to its angle of repose, and is connected electrically to the control box 84', or to directly control the blower.

A perforated vacuum hose 96' is positioned between the walls of the bag 28' at the outside periphery of the bottom to assure that the bag assumes its original position during deflation.

In operation, the bin 10' of Fig. 7 is initially filled with the bulk material to be stored, e.g. sugar, rice, corn, powders, grains, etc. This material should be

free flowing material and of a type which can be handled within the bin. Fig. 15A shows the bin loaded with material. When it is desired to discharge material from the bin, gate 68' is opened by virtue of pulling on handle 70' and the material flows out of the bin and out of the discharge opening until such time as it approximates its angle of repose and uncovers the sensor of bin material indicator 94'. At this time the material is in the condition of Fig. 15B. When it senses no material the bin level indicator 94' gives a signal to the control box 84' to start inflating the bag by relatively low pressure from the blower 76'. The top of the bag 28' starts inflating by the inner wall 30' bulging inwardly as shown in Fig. 15C. The material continues to flow and the bag wall 30' continues to expand as shown in Figs. 15D and 15E. During discharge when the material covers the indicator 94' the inflation stops, the check valve 88' holds the low pressure, and the material discharges by gravity until it again uncovers the indicator. This cycle is repeated during the discharge. Near the end of the emptying cycle the inner wall 30' of the bag 28' has raised off the bottom and lifted the small amount of material remaining into the discharge opening, see Fig. 9F.

For deflating the bag and causing it to assume its original position, vacuum applied through perforated vacuum hose 96' draws the bottom of the inner bag wall into the bottom corners of the bin. Inflated torroidal tube 97' is provided to assure that enough slack exists so that the walls of bag 28' are not unduly strained when the bag is again loaded with bulk materials.

If at any time during the discharge there was a problem it could be inspected through transparent hatch 60' and if access is required at the point of discharge the hatch can be opened. Other transparent viewing areas can be provided in the bin wall.

As a safety measure and to prevent overpressure on the bag wall and consequent damage to the bag during the

discharge cycle a pressure relief means is included in the blower system. Overpressure could occur if there were a malfunction of the probe and/or blower, a blockage of material near the probe causing it to misread material flow, or a malfunction of the shut off switch over the bin is completely emptied. An accurate, simple and inexpensive pressure relief means for the very low pressures involved (1/4 to 1 psi or about 6 to 28" water gauge) is shown in Fig. 19. A manometer 110 is connected to blower outlet 78' via line 112, of the same diameter and having a check valve 114 therein. A vented collection connector 116 surrounds the outer leg of the manometer. The system illustrated provides a pressure relief at 22 inches of water because at any higher pressure the water will be blown out of the manometer into the canister. The check valve prevents vacuum from sucking the water into line 78'. The manometer can be easily refilled with water after a pressure relief blow out.

Figs. 12, 13 and 14 show alternative embodiments in which, for various reasons, it is desirable to have the discharge opening 16' several feet above the level of the floor. In the Fig. 12 and 13 embodiments a false floor 90' which may be installed on top of a honeycomb support 100' is positioned to raise the level of the bottom of the bin until a point just below the discharge opening 16'.

Fig. 14 represents another approach to the problem in which the floor is a tapered false floor 102' tapering upwardly from a point at the floor opposite the discharge opening to a point above the floor and just below the discharge opening.

The advantage of both the Fig. 12 and Fig. 14 embodiments is in having the discharge opening above the level of the floor but not requiring the bag 28' to lift relatively heavy weight of material being discharged any significant distance.

Fig. 16 shows another and presently preferred embodiment. The parts illustrated in Fig. 16 which are

substantially the same as those in Fig. 7 bear the same reference numerals. Fig. 16 for example has the same double walled slanted top cup shaped bag 28' clamped to the walls by annular clamp 38'. Additionally, the embodiment of Fig. 16 shows in more detail the inflatable tube 97' with an inflation opening 99' therefor. This inflatable tube or collar extends around the periphery of the bin below the clamp 38'. By inflating tube 97' slack is provided for the inner wall 30' of bag 28'. Thus, this slack is needed when loading the bag with heavy material which causes the bag to conform to the corrugations of the outer wall 14'. By allowing such strain to be absorbed by the air in the inflatable tube 97' strain is removed to a large extent from the clamp 38' and walls of the bag.

Additionally, inflatable tubes 102' and 104' may be placed at levels above the clamp 38' and provided with suitable inflation openings 103' and 105' for further assisting in the discharge of the materials if the top end of the inflatable bag does not reach the top side of the bin opposite the discharge opening.

In the Fig. 16 embodiment a screw conveyor 106' extends radially from the bin at an angle to the floor to provide discharge at a suitable level to equipment, further storage, etc. This conveyor is beneath a built up false floor 108' also extending at an angle across the segment of the floor. A discharge opening 16' in the floor above the conveyor is closed by a hand operated slide gate 110'. The indicator probe 94' is positioned above the discharge opening 16' and a access opening 112' is provided to allow inspection of the discharge area and access thereto.

In operation of this embodiment reference is had to Figs. 17A-D consecutively. As shown in Fig. 17A the bulk material M will flow by gravity at the discharge when the gate 110' is removed and the conveyor 106' is operative. To assist in discharge above the line of clamp 38' tube 102' is inflated, see Fig. 17C, and later tube 104' may be inflated as in Fig. 17D.

In all embodiments the inner wall of the inflatable bag is self cleaning. This is believed to be due to its periodic flexing and the fact that the material always flows by gravity without being lifted or forced by the bag under high pressure.

Figs. 18A-F illustrate the use of the perforated vacuum tube or hose 96' and the inflatable bag during the deflation and reloading of the bin. As seen in Fig. 18A deflation is starting and vacuum is applied to perforated vacuum hose 96' and at the same time inflatable tube 97' is inflated to bulge it, see Fig. 18B. Thereafter the bag gradually assumes its original position fitting snugly into the corners of the cylindrical bin as shown in Figs. 18C, D and E. However, the inner wall will be bulged out to provide slack when loading the bin as shown in Fig. 18E. Fig. 18F shows how this slack is provided and such is useful in allowing the inner wall to conform to the corrugations in bin wall 14' and otherwise stretch as needed to fill voids when refilling the inner bag with the bulk material to be stored. The inflatable collar 97' may be inflated by the same power source that provides the vacuum to perforated vacuum hose 96'.

In the center discharge embodiment (e.g. Fig. 1), the sensing probe to control the inflation can be in a separate hopper between the bin discharge and a conveyor. As shown in Fig. 1 the discharge conduit 30 leads to a hopper 130 and is controlled by valve means 32 (which can also be a slide valve positioned at the discharge opening 22). The hopper feeds to a conveyor 132 for carrying the material away. A probe 134 is similar in construction, function and operation to probe 94' in the side unloading embodiment.

As can be seen the invention disclosed provides a unique pneumatically assisted handling and discharge means for granular free flowing material in which the bin for storing the material is simple and inexpensively constructed, it has uniform weight distribution over a supporting floor and can automatically assist in

discharging material beyond the angle of repose by automatically inflating the supporting double walled bag. As compared with conventional bulk storage and hoppers the present invention presents dramatic differences in size of the silos required, shipping weight, erection time equipment and costs, floor loading, maintenance and cost.

WE CLAIM:

1. A bin for free flowing granular material having a bottom resting on a support member, a bin structural side wall extending upward from said bottom and a pneumatically actuable flexible member for forcing the free flowing granular material toward a discharge going in the bin, with the improvements comprising; the flexible member being a hollow, inflatable generally cup shaped bag having an inner wall and an outer wall with a discharge opening therethrough, means for suspending the top of the bag from the side wall, means for anchoring the outer wall of the bag at the bottom of the cup side wall, means for inflating the hollow flexible bag after the bin has been partially emptied by gravity to force remaining material to flow out the drainage opening; and means for deflating the hollow bag and causing it to assume its original position.

2. A bin as defined in claim 1 wherein the cup-shaped bag is formed in sections.

3. A bin as defined in claim 1 wherein the cup-shaped bag is anchored to the floor at, and in registry with, the discharge opening.

4. A bin as defined in claim 1 wherein the bin structural side wall is adjacent the outside of the outermost wall of the cup-shaped bag.

5. A bin as defined in claim 4 wherein the bin structural side wall is a corrugated metal wall.

6. A bin as defined in claim 4 wherein the means for anchoring the outer wall of the cup-shaped bag comprises the bottom of the bin structural wall attached to the floor with a portion of the bag wall therebetween.

7. A bin as defined in claim 4 wherein the means for supporting and holding up the top of the side walls of the cup-shaped bag constitutes the bin structural side wall.

8. A bin as defined in claim 1 further comprising means for creating slack in the flexible material including a flexible annulus with separate means for inflating the

same, the annulus positioned behind at least the innermost wall of the flexible walls of the bag.

9. A bin as defined in claim 1 further comprising means for creating slack including a folded section of the side wall of the bag and a spring means for supporting the folded section.

10. A bin as defined in claim 1 wherein the means for inflating the bag includes a source of gas under pressure, and the means for deflating the bag includes a source of gas under negative pressure.

11. A bin as defined in claim 1 further comprising the cup-shaped bag having a means attaching the top of the walls of the bag to the bin side wall means from a low point adjacent the discharge opening to a high point on the side of the bin generally opposite the discharge opening.

12. A bin according to claim 11 wherein the top of the walls of the cup-shaped bag are attached to the inside of the bin side wall means in a continuous manner by clamp means from an area slightly above the discharge opening on one side of the bin to a higher level on the other side of the bin.

13. A bin according to claim 12 wherein the walls of the cup-shaped bag are sealed together to prevent separation in an area extending from the discharge opening and flaring outwardly and upwardly to the area slightly above the discharge opening where the bag is sealed to the side wall.

14. A bin according to claim 11 further comprising a discharge shroud extending outwardly from the bin side wall means at the discharge opening.

15. A bin according to claim 14 wherein the discharge shroud has a discharge gate in the bottom and an openable hatch in the top.

16. A bin according to claim 15 further comprising a conveyor positioned with a portion thereof beneath the discharge gate.

17. A bin according to claim 1 further comprising material detection means positioned in the bin adjacent the discharge opening to provide an output signal indicating whether material is flowing in an area immediately above the angle of repose adjacent the discharge, means connecting the output signal of the material detection means to control the inflation means so that the bag will inflate slightly before the bin is emptied to a level equal the angle of repose of the material in the bin.

18. A bin according to claim 17 further comprising a false bottom beneath the bag to the floor to raise the bottom of the bag to a position slightly below the discharge.

19. A bin according to claim 18 wherein the false bottom is of tapered height, with its highest point slightly below the bottom of the discharge opening.

20. A bin according to claim 1 further comprising a perforated tube connected to a source of vacuum, the perforated tube positioned inside the flexible double walled bag adjacent the outer bottom thereof and functioning on the application to deflate the bag and draw the inner back to its original position for refilling.

21. A bin according to claim 1 further comprising an annular inflatable side wall slack creating tube positioned inside the bag just below the top thereof.

22. A bin according to claim 21 wherein there is at least one inflatable annular tube above the clamp which is selectively inflatable to aid in gravity discharge of the material in the bin.

23. A bin according to claim 22 wherein there are at least two such inflatable annular tubes, one adjacent another, and means for sequentially inflating them from the top down.

24. A bin according to claim 1 wherein the discharge is adjacent a slanted false floor, and further comprising gate means controlling flow through the discharge area in the false floor.

25. A bin according to claim 24 further comprising an access point adjacent the gate means, and a material sensor adjacent the discharge area constituting a portion of a control for the means for inflating the bag.

26. A bin according to claim 24 wherein the means for discharging material is a screw conveyor extending outwardly of the bin side wall means from beneath the top of the false floor.

27. A bin according to claim 1 wherein the means for inflating the bag includes a source of gas under pressure, controls for such source, and a material sensing means adjacent the discharge area which would not normally be contacted by the free flowing material after it has assumed its angle of repose with respect to the discharge opening.

28. A bin according to claim 27 further comprising a pressure relief means connected to the means for inflating the bag and operable in the ranges of one pound per square with gauge pressure.

29. A bin according to claim 28 wherein the presure relief means comprises a manometer connected to the means for inflating the bag via a check valve.

30. A bin according to claim 1 further comprising a material holding means below the discharge opening feeding a conveyor means and material sensing means in the material holding means for detecting the presence of material to control the inflation means.

AMENDED CLAIMS
(received by the International Bureau on 27 September 1982 (27.09.82))

1. (Amended) A bin for free flowing granular material having a floor, a bin structural side wall extending upward from said floor and a pneumatically actuable flexible member for forcing the free flowing granular material toward a discharge opening in the bin, with the improvements comprising; the flexible member being a hollow, inflatable generally cup shaped bag having an inner wall and an outer wall with a discharge opening therethrough anchored in registry with the bin discharge opening, means for suspending the top of the bag from the bin side wall, means for anchoring the bottom of the outer wall of the bag to the bottom of the bin side wall, means for gradually inflating the hollow flexible bag after the bin has been partially emptied by gravity to cause remaining material to flow out the discharge opening; and means for deflating the hollow bag and causing it to assume its original position.

2. (Cancelled)

3. (Cancelled)

4. (Cancelled)

5. (Cancelled)

6. (Amended) A bin as defined in claim 1 wherein the means for anchoring the outer wall of the cup-shaped bag comprises the bottom of the bin structural wall attached to the floor with a portion of the outer bag wall anchored therebetween.

7. (Cancelled)

8. (Amended) A bin as defined in claim 1 further comprising means for creating slack in the inner wall of the bag including a flexible annulus with separate means for inflating the same, the annulus positioned behind at least the innermost wall of the walls of the bag adjacent to the top thereof.

9. (Amended) A bin as defined in claim 1 further comprising means for creating slack in the inner wall of the bag including a folded section of the inner wall of the

bag adjacent to the top thereof and spring means for supporting the folded section.

10. (Cancelled)

11. (Cancelled)

12. (Cancelled)

13. (Cancelled)

14. (Cancelled)

15. (Cancelled)

16. (Cancelled)

17. (Amended) A bin as defined in claim 1 further comprising material detection means positioned in the bin adjacent the discharge openings to provide an output signal indicating whether material is flowing in an area immediately above the angle of repose adjacent the discharge openings, means connecting the output signal of the material detection means to control the inflation means so that the bag will inflate slightly before the bin is emptied to a level equal the angle of repose of the material in the bin.

18. (Cancelled)

19. (Cancelled)

20. (Cancelled)

21. (Cancelled)

22. (Cancelled)

23. (Cancelled)

24. (Cancelled)

25. (Cancelled)

26. (Cancelled)

27. (Cancelled)

28. (Amended) A bin as defined in claim 1 further comprising a pressure relief means connected to the means for inflating the bag and operable in the range of 15 to 72 cm water gauge pressure.

29. (Cancelled)

30. (Amended) A bin as defined in claim 1 further comprising a material holding means below the discharge opening feeding a conveyor means, and material sensing

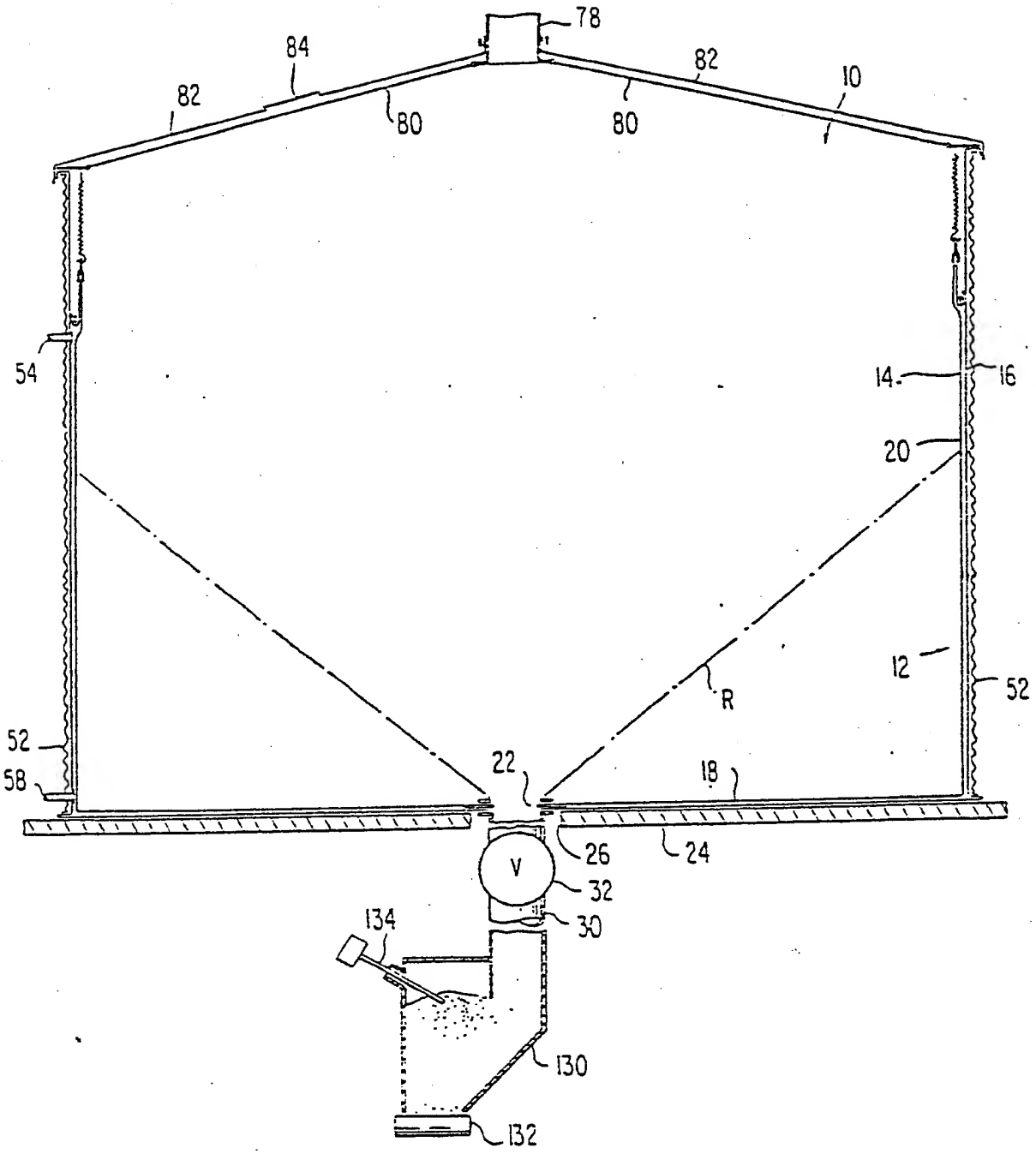
means in the material holding means for detecting the presence of material to control the inflation means.

31. (New) A bin as defined in claim 1 wherein the inflating means first inflates the top of the bag, and the deflating means includes a perforated tube connected to a source of vacuum, the perforated tube positioned inside the flexible double walled bag adjacent the outer bottom thereof and functioning on the application of vacuum to deflate the bag and draw the inner wall back to its original position for refilling of the bin.

32. (New) A bin as defined in claim 1 wherein the bin discharge opening is in the bin sidewall, the means for suspending the top of the bag includes clamp means extending from a low point adjacent the bin discharge opening to a high point on the side of the bin generally opposite to the bin discharge opening.

33. (New) A bin as defined in claim 32 wherein the bin includes a discharge access adjacent the discharge opening; and the bin also includes a false bottom on the floor beneath the bag wherein the false bottom is tapered with its highest point slightly below the bottom of the charge openings.

FIG.1



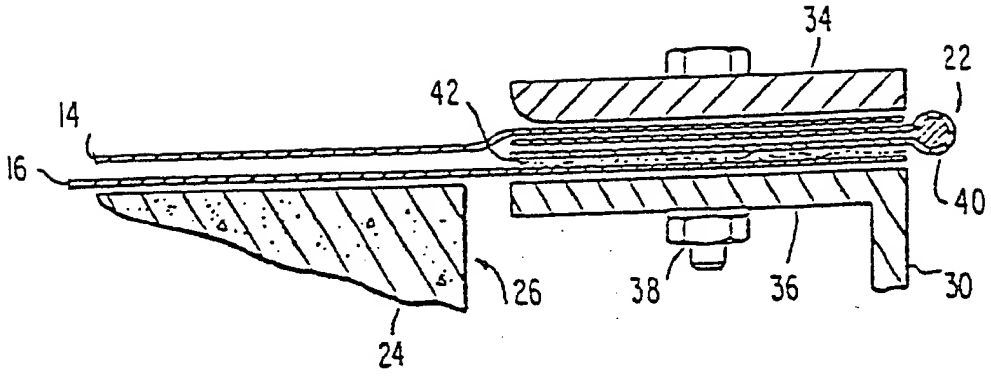
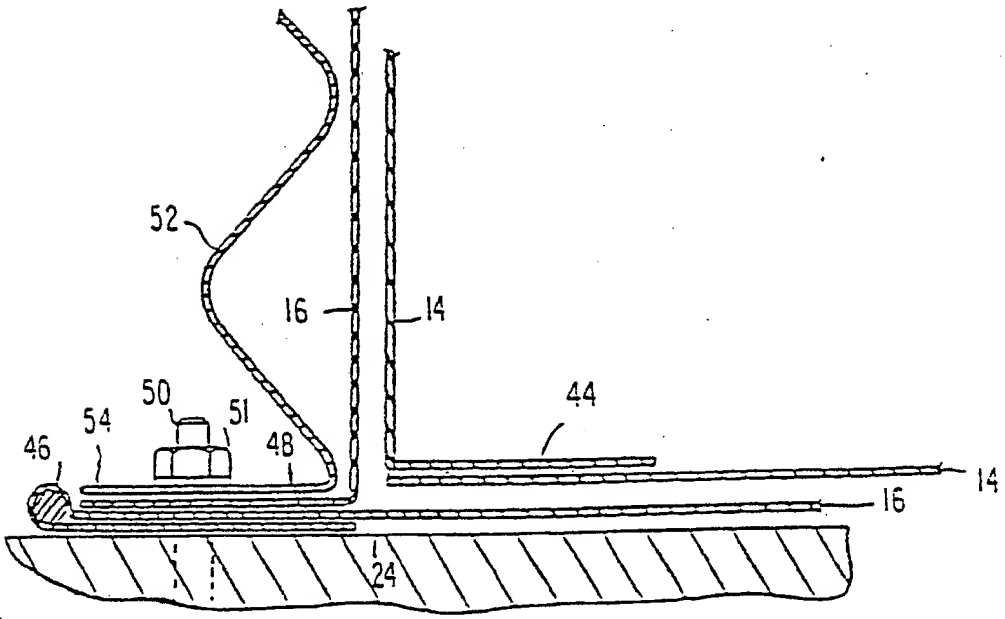


FIG. 2

FIG. 3



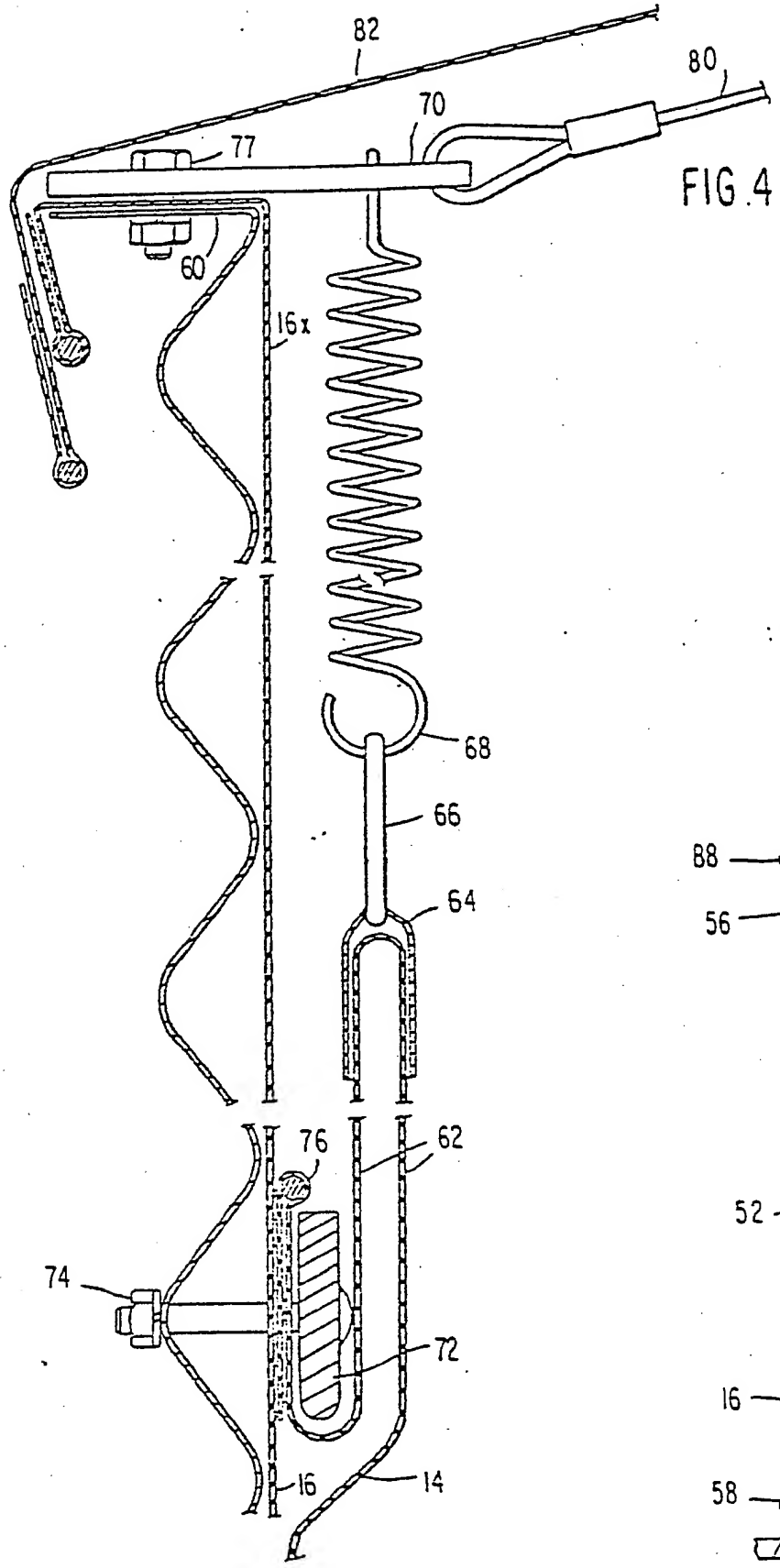
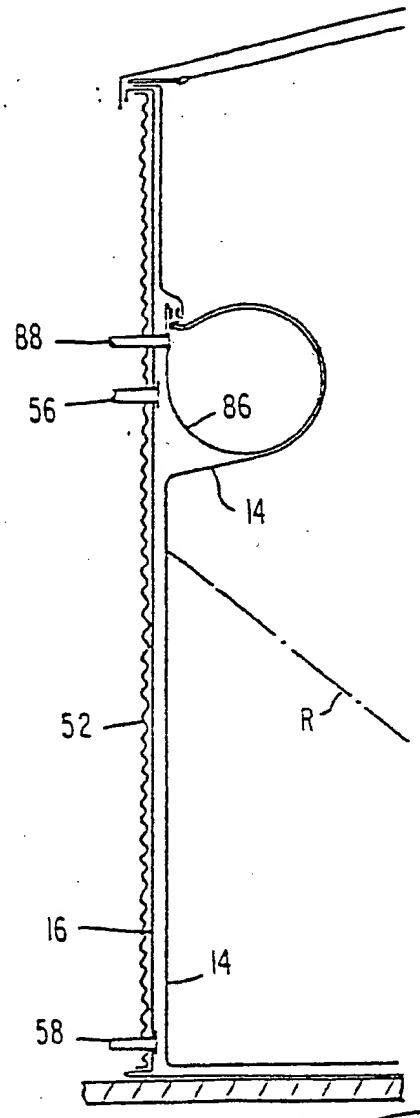


FIG.4

FIG.5



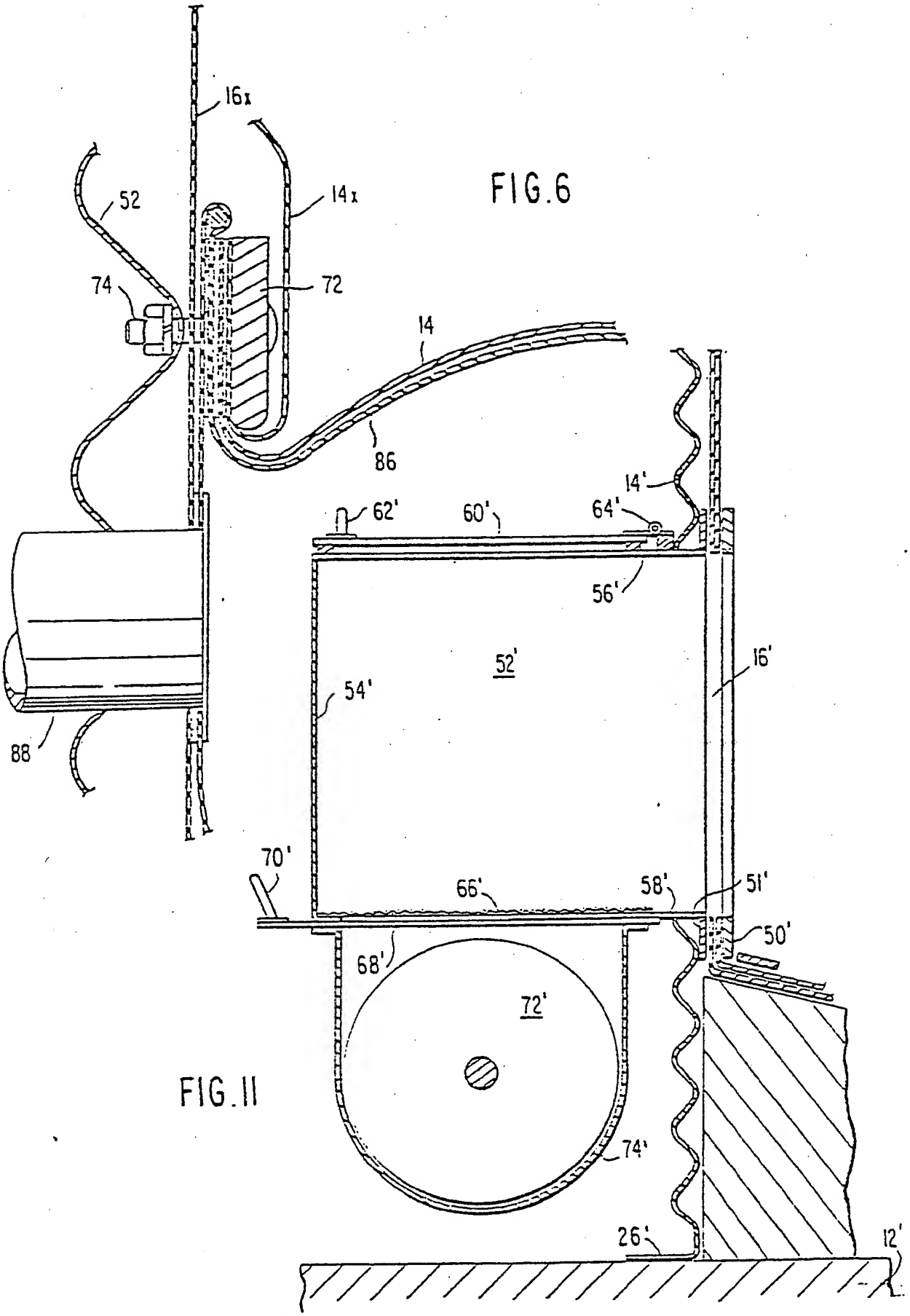
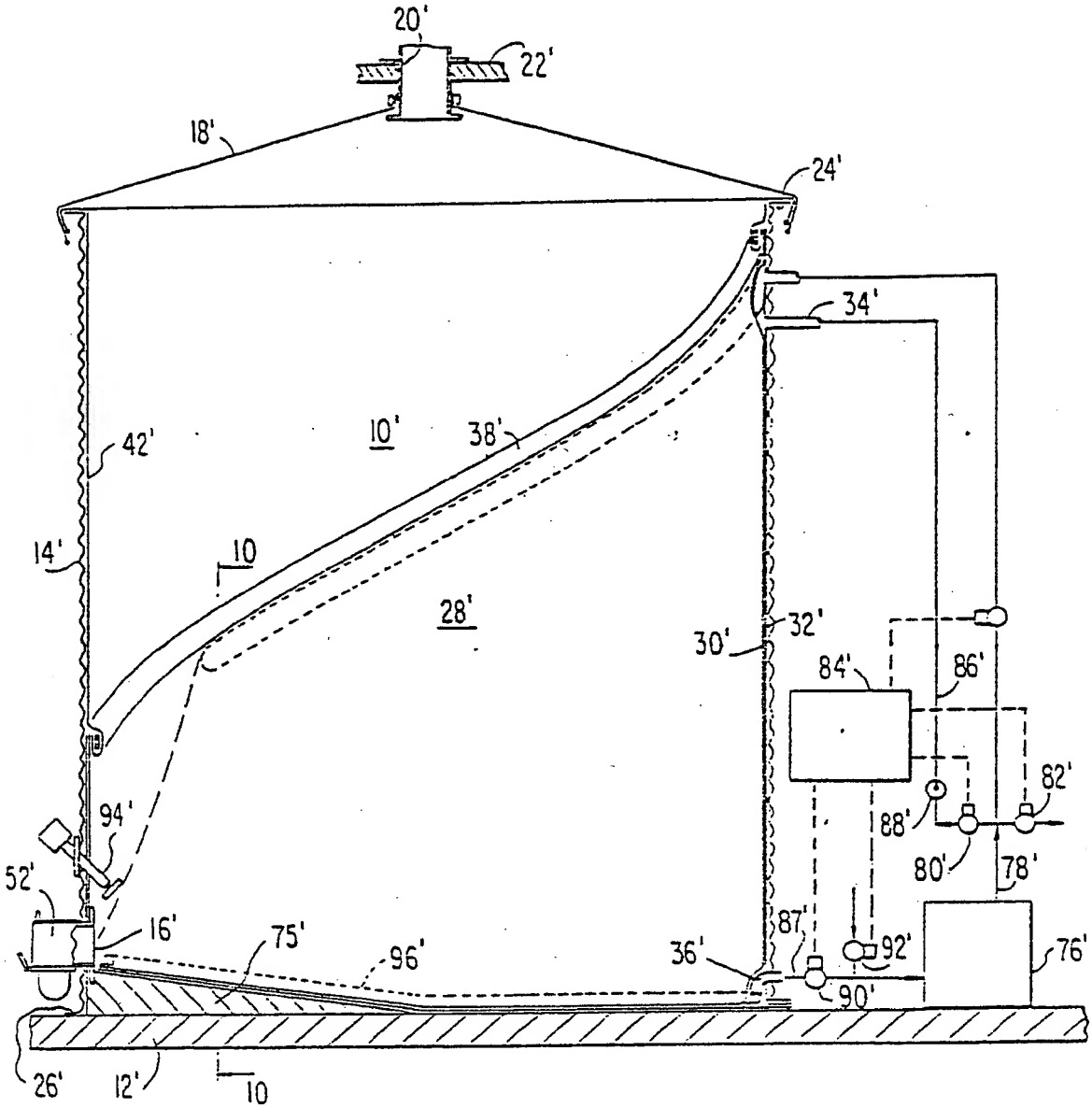


FIG.6

FIG.11

FIG.7



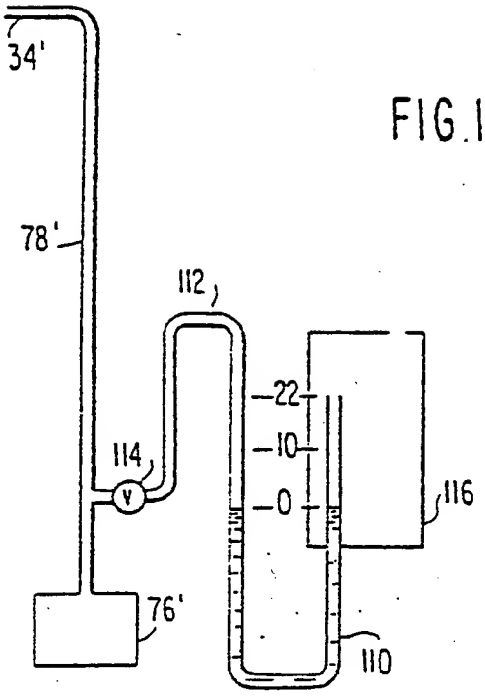


FIG.19

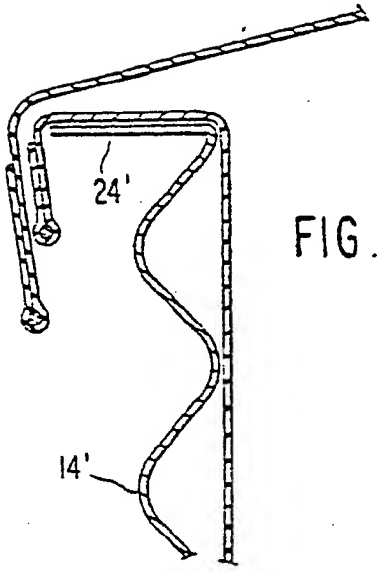


FIG.8

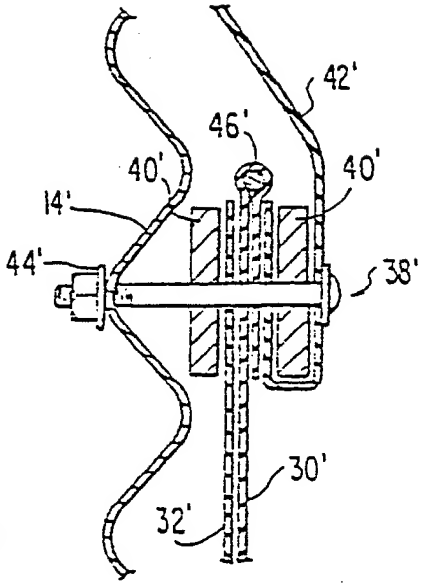


FIG.9

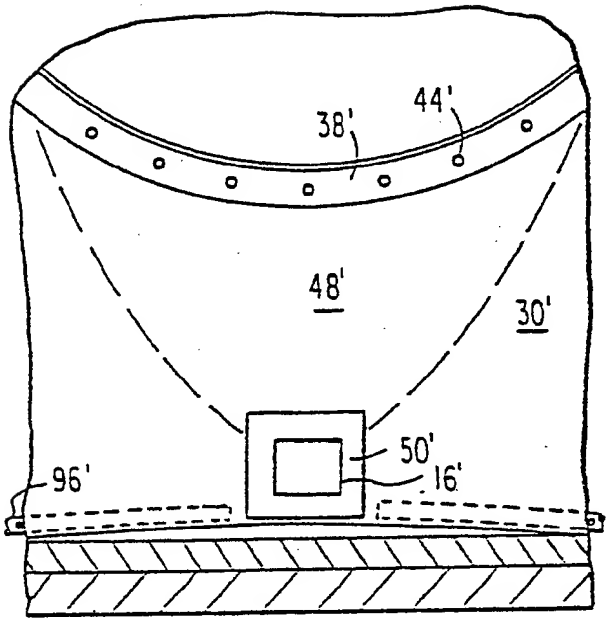


FIG.10

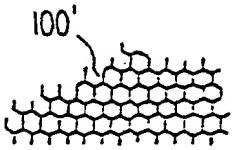
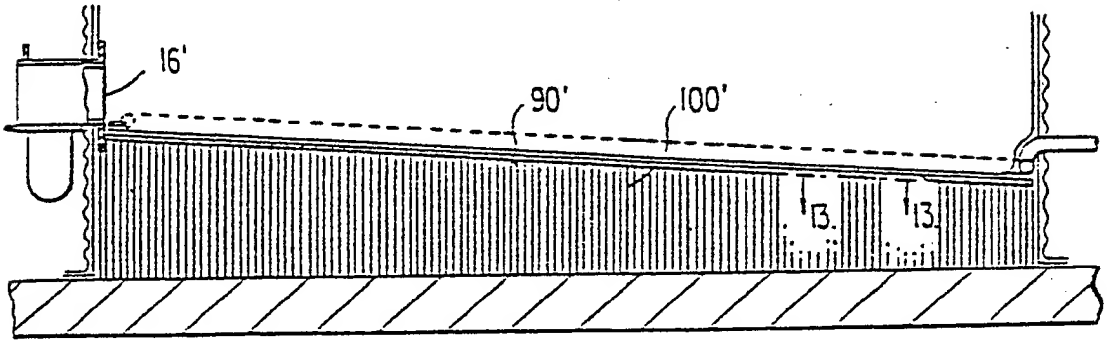


FIG.13

FIG.12



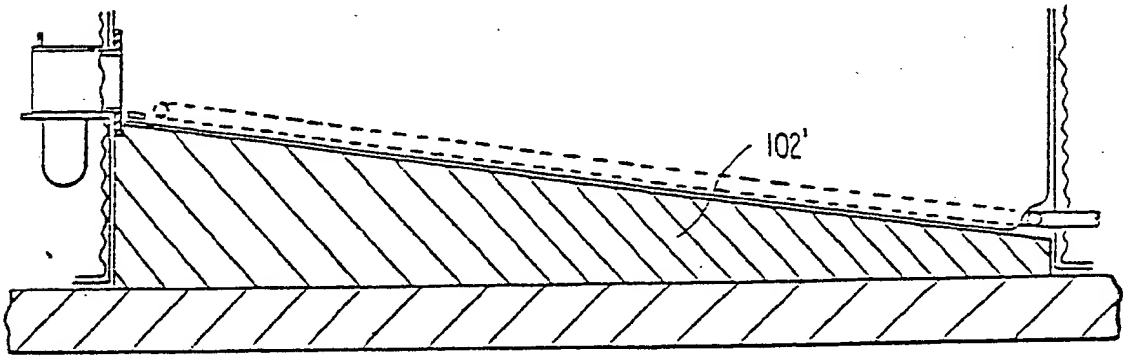


FIG.14

FIG.15A

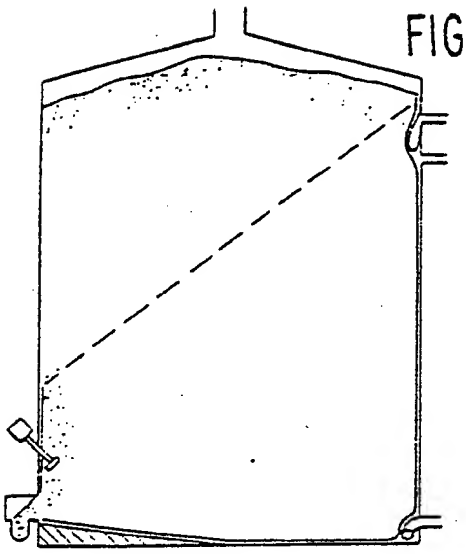


FIG.15B

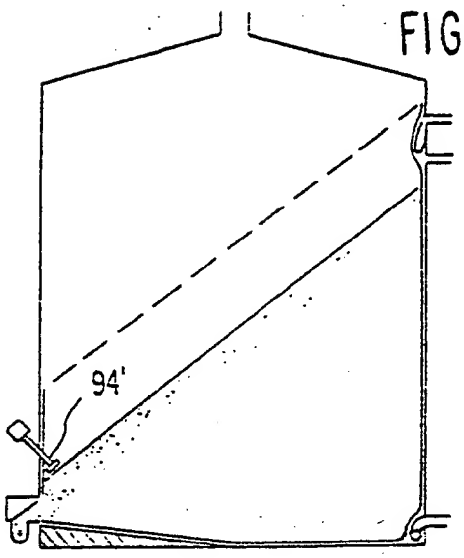


FIG.15C

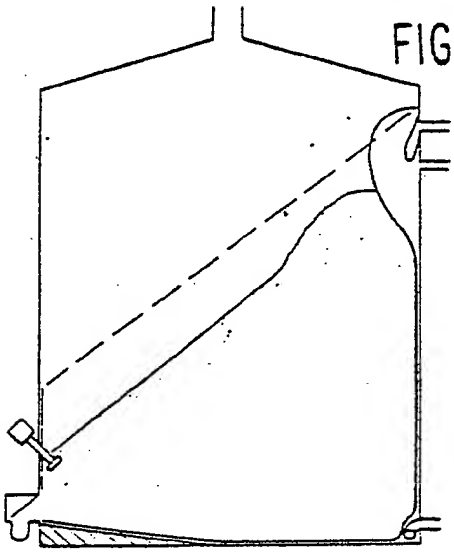


FIG.15D

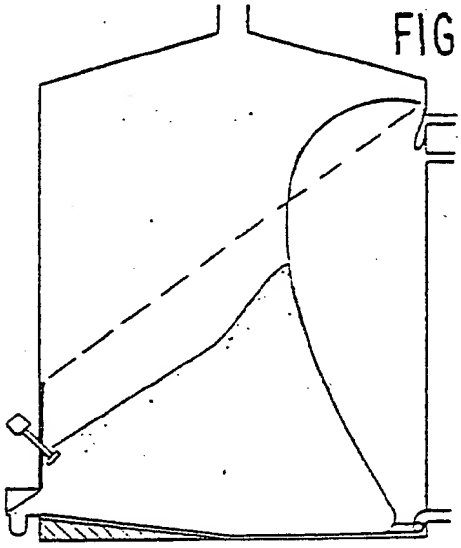


FIG.15E

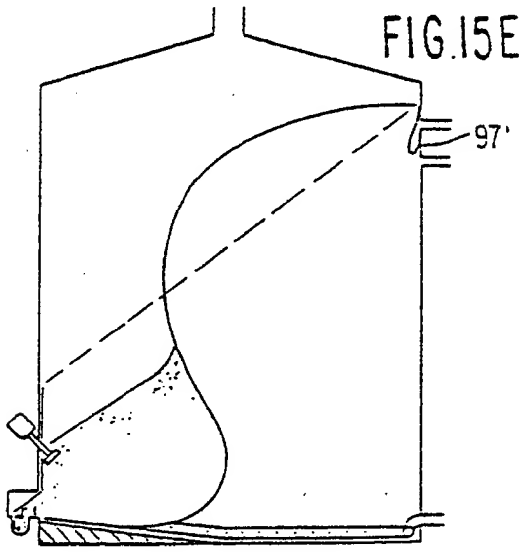


FIG.15F

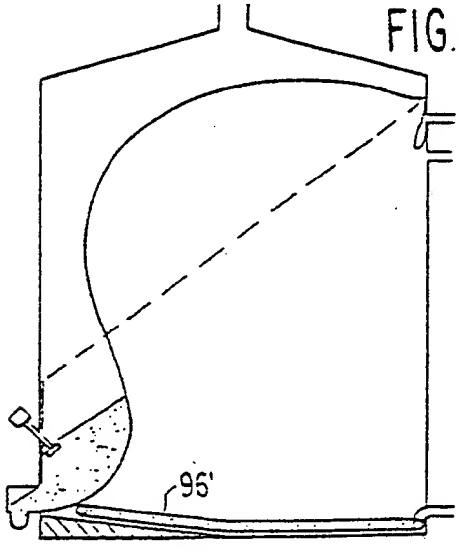


FIG.16

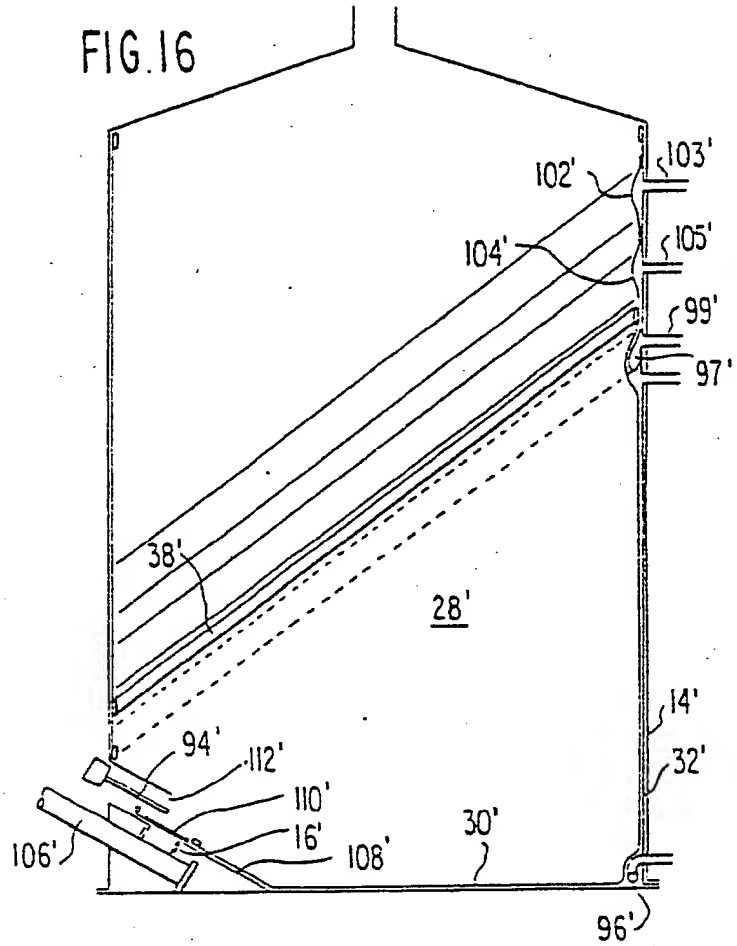


FIG.17A

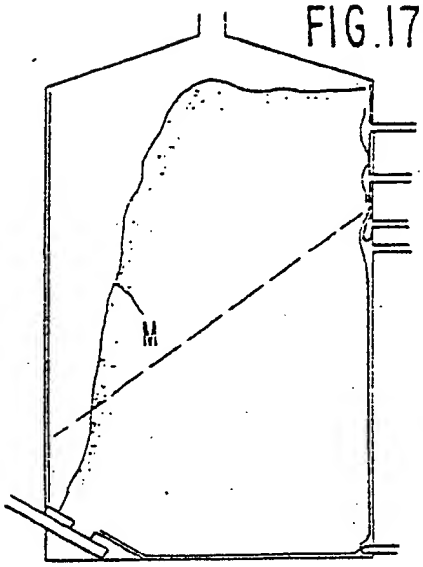


FIG.17B

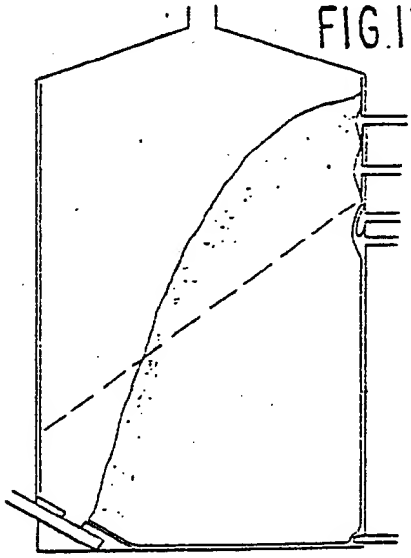


FIG.17C

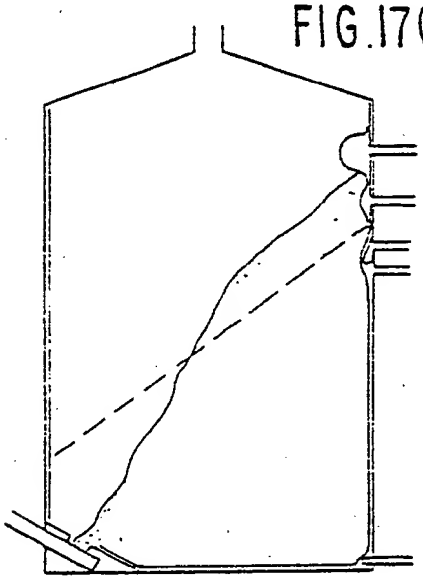


FIG.17D

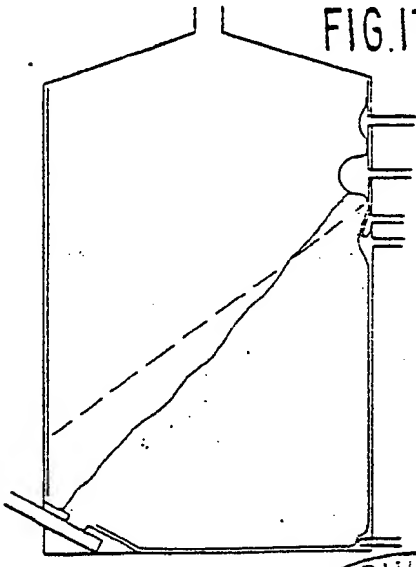


FIG.18A

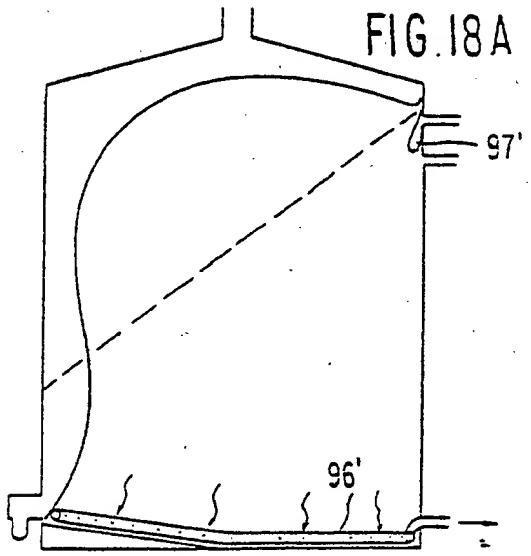


FIG.18B

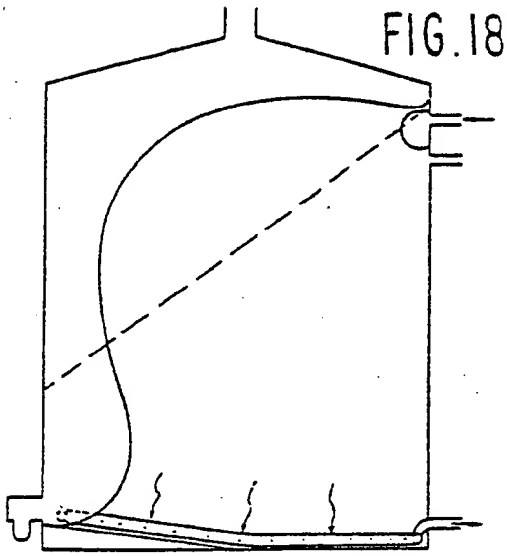


FIG.18C

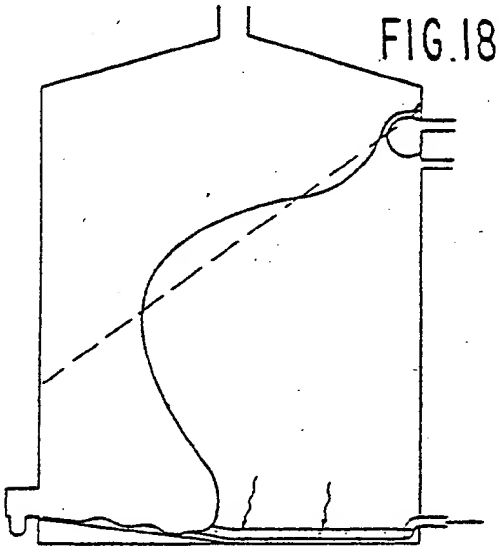


FIG.18D

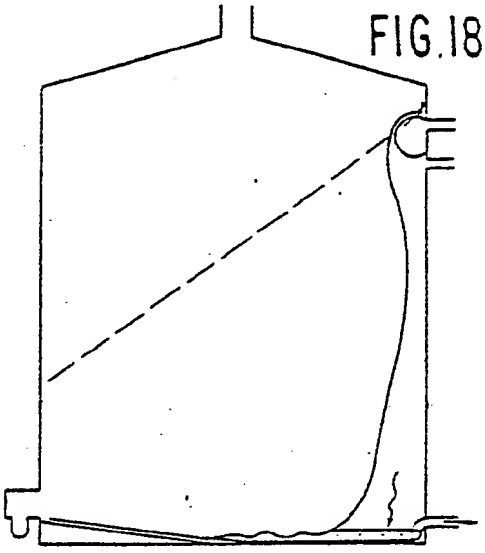


FIG.18E

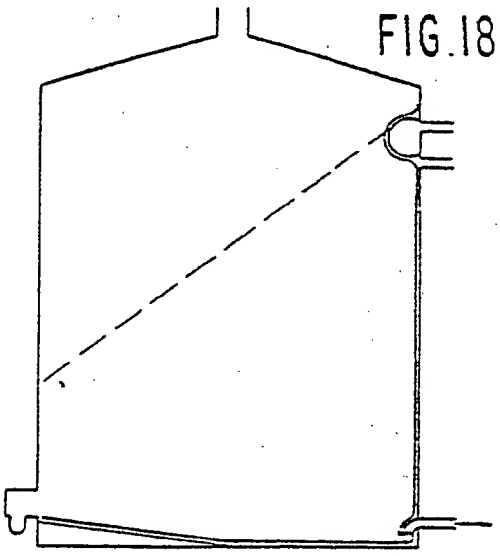
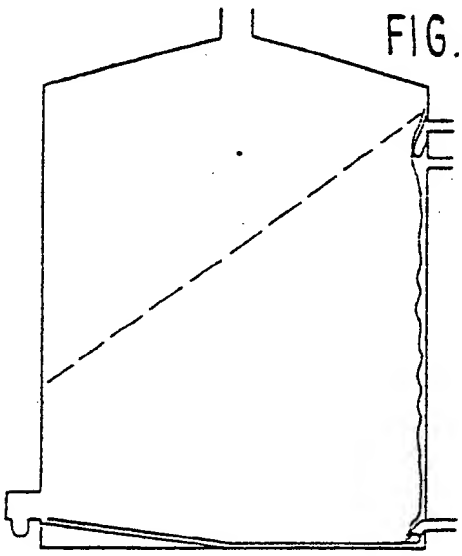


FIG.18F



INTERNATIONAL SEARCH REPORT

International Application No PCT/US 82/00510

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[3] B65D 88/16, 88/62, 90/04
U.S. Cl. 222/64, 386.5, 413

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
US	222/64, 105, 203, 386.5, 413 52/195, 197 414/304, 323

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
Y	US, A, 2,956,839, Published 18 October 1960, Hermanns.	1,3-4,7, 11-12
Y	GB, A, 1,089,874, Published 08 November 1967,	1,4,6-7
Y	GB, A, 1,144,162, Published 05 March 1969, Partridge.	1,3-4,7,10, 20
	US, A, 3,351,235, Published 07 November 1967, Paton.	
Y	US, A, 4,169,543, Published 02 October 1979, Hall.	17,30
Y	US, A, 2,722,171, Published 01 November 1955, Deringer.	18
	DE, A, 2,062,630, Published 29 June 1972, Schulz.	

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
11 August 1982	17 AUG 1982
International Searching Authority [1]	Signature of Authorized Officer [20]
ISA/US	Charles A. Marmor 8/12/82 Charles A. Marmor

Form PCT/ISA/210 (second sheet) (October 1981)

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